

CLEAN CLAIMS AFTER JANUARY 24, 2001 AMENDMENT



A1
11. The method of Claim 10 wherein said pulse sharpening device modifies both the leading edge and the trailing edge of said laser pulse.

19. An apparatus for laser peening a workpiece, said apparatus comprising:

• a substantially single-transverse-mode laser oscillator to create a laser pulse;

5 • a laser pulse-sharpening device to sharpen said laser pulse; • means for amplifying said laser pulse; and
a laser peening cell into which said pulse is directed.

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20. The apparatus of Claim 19 wherein said oscillator also provides means for compensating for stress birefringence.

21. The apparatus of Claim 20 wherein said oscillator comprises a dual-pump-cavity configuration with a 90 degree rotator between the pump cavities.

22. The apparatus of Claim 20 wherein said oscillator further comprises a porro prism.

23. The apparatus of Claim 19 wherein said oscillator also provides means for generating a single-longitudinal-mode laser pulse.

24. The apparatus of Claim 23 wherein said means for generating a single-longitudinal-mode is a seed laser.



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25. The apparatus of Claim 23 wherein said means for generating said single-longitudinal-mode laser pulse is an etalon.

26. The apparatus of Claim 19 wherein said oscillator contains an aperture with an opening of less than 5 mm.

27. The apparatus of Claim 19 wherein said oscillator utilizes a gradient reflector.

28. The apparatus of Claim 19 wherein said pulse sharpening device is an electro-optical pulse slicer.

29. The apparatus of Claim 28 wherein said pulse sharpening device modifies both the leading edge and the trailing edge of said laser pulse.

30. The apparatus of Claim 28 wherein said pulse sharpening device is a phase conjugation device.

31. The apparatus of Claim 19 wherein said amplifying means is a series of Nd:glass amplifiers.

32. The apparatus of Claim 31 wherein said amplifying means further comprises a means for birefringence compensation of the laser pulse as said laser pulse passes through said amplifying means.

33. The apparatus of Claim 32 wherein said means for birefringence compensation is a 90 degree rotator.

34. The apparatus of Claim 19 wherein said amplifying means is by multi-pass amplification.

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35. The apparatus of Claim 34 wherein said multi-pass amplification comprises a phase conjugation device and a means for birefringence compensation.

36. The apparatus of Claim 35 wherein said means for birefringence compensation is a 90 degree rotator.

Claims 11 and 29 stand objected to because the Examiner states that they recite an intended use. Applicant has amended Claims 11 and 29 to more clearly indicate that the pulse sharpening device modifies both the leading edge and trailing edge of the laser pulse. Applicant respectfully requests this rejection to be withdrawn.

Claims 20-36 stand objected to since such claims recite a method that are dependent upon an apparatus claim, independent Claim 19. Applicant has amended Claims 20-36 to correctly indicate that such claims are apparatus claims. Applicant respectfully requests the objection to be withdrawn.

Claim 19 stands rejected under 35 U.S.C. § 112, second paragraph. Applicant has amended Claim 19 to more clearly state the cooperation between the claim elements. Applicant respectfully requests the rejection of Claim 19 under 35 U.S.C. § 112, second paragraph, to be withdrawn.

Claims 1, 3, 8, 12-18, 19, 21, 26, and 30-38 stand rejected as obvious over Epstein and a number of different references. The Examiner states that it would have been obvious to one of ordinary skill in the art at the time that the invention was made to apply the teachings of Hans and Heppner to Epstein because the Hans and Heppner references disclose a technique of obtaining a single transverse mode laser to avoid damages to the optical system which would prolong the life of a laser system. Applicant

respectfully submits that the Examiner is erroneously inserting the single transverse mode oscillators from the references into the Epstein laser peening patent, without the necessary teaching, suggestion, or inference of the references to combine same.

5 Applicant respectfully submits that the Examiner is utilizing an advantage of the single transverse mode laser (prolonging life of the laser system), and therefore, inserting and replacing the oscillator in the Epstein reference part and parcel without any explicit or implicit teaching to combine same.

10 The present invention relates particularly to a use of a single mode or substantially single transverse mode oscillator in a laser peening system or alternatively utilized in a method for laser peening a workpiece. Applicant respectfully states that none of the prior art of laser peening laser systems teach or
15 would show that such utilization is obvious.

Traditionally, laser peening systems have always attempted to apply more energy to the workpiece. Such additional energy would increase the laser peening effects to the workpiece, resulting in more or higher amplitude compressive residual
20 stresses in the work piece. To obtain higher stresses, larger amounts of laser energy have been sought in laser peening laser systems. Conventional thought was that it was necessary to start out with a higher energy oscillator, particularly that of the multi-mode oscillator shown in Epstein and others. Such multi-

mode type oscillators typically are able to generate, produce, and provide at least 0.5 joule or 1.0 joules at the beginning of the laser amplification chain of the laser peening system. By starting off with a higher amount of energy out of the oscillator, fewer numbers of laser amplification heads were needed.

As understood, the typical known substantially single transverse mode oscillators have a power output in the range of 40 millijoules. If such use of a single mode or single transverse mode oscillator would have thought to have been used in a laser peening system, additional amplification heads would have been necessary to generate the desired laser beam power. Of course, additional amplification heads would increase the cost of the laser peening system while at the same time utilizing more and more optics and laser amplification rods. This brings with it its own problem of nonlinearity and increasing the $\phi\beta$ for the system to too high a level, such that nonlinear focusing effects are evident with the greater number of amplification heads. If a single mode or single transverse mode oscillator would have thought to have been used, the amplification chain would have needed excessive gain and the system would not have been practical in use. Further, with additional amplification heads and optics, amplified back reflection or parasitic oscillation would have occurred back through the amplifier chain. Therefore,

traditional thought would have concluded that single transverse mode oscillators were insufficient in terms of power output and through the need of additional optical amplification an increased chance of back reflection and other internal laser system problems would have resulted.

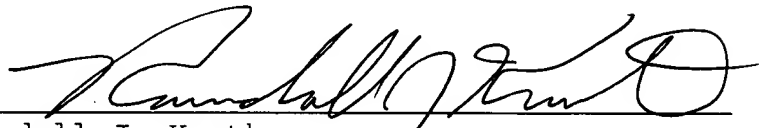
Therefore, the use of the single mode oscillator, or single transverse mode oscillator in a laser peening or laser shock peening laser system would not have been used and would have been opposite of conventional thought. The combination of the Epstein laser peening system with the single mode oscillators of the Hans and Heppner reference would not have been obvious to combine. Additionally, none of the references teach or suggest utilizing one with the other. Applicant respectfully requests the Examiner to withdraw the rejections to the independent claims of the application. Further Applicant respectfully submits that the claims dependent upon these now allowable independent claims would be allowable for the same reason. Applicant respectfully requests all of the rejections under § 103 to be withdrawn.

Applicant appreciates the Examiner's indication of allowable subject matter of Claims 5-7, 9, 23-25, and 27.

Applicant respectfully requests a notice of allowability to be forwarded to the undersigned.

If the Examiner has any questions or comments that would speed prosecution of this case, he is invited to call the undersigned at 219/485-6001.

Respectfully submitted,


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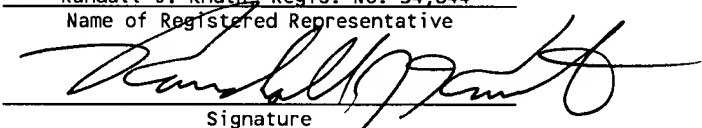
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I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Hon. Commissioner of Patents and Trademarks, Washington, D.C. 20231, on: January 24, 2001.

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Signature
January 24, 2001
Date